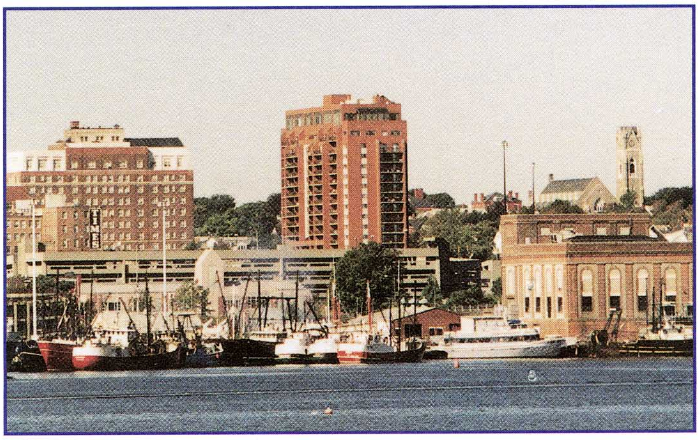
Imprint of the Past:

Ecological History of New Bedford Harbor



Photographs on cover

top: Schooner Unloading Bricks, c. 1890, Henry P. Willis. View of New Bedford shore line just south of New Bedford - Fairhaven Bridge. Street at left is Middle Street. The tower on right, seen through the rigging of the schooner, is St. Lawrence Roman Catholic Church, which is still there today.
New Bedford Whaling Museum collection.

bottom: Current photograph of New Bedford shore line south of New Bedford - Fairhaven (Rt.6) Bridge. Tower and roof-line of St. Lawrence Roman Catholic Church is visible on the skyline on right. ***Photograph by Carol Pesch.***

Imprint of the Past:

Ecological History of New Bedford Harbor

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Definitions of bold face words can be found in glossary on page 27.

Recently, the U.S. Environmental Protection Agency (EPA) adopted a new approach to study and manage environmental problems. In the past, the agency's emphasis was on particular pollutants and their effects on individual species in air, land, and water. But the environment is not a series of compartments, it includes a series of interconnected aquatic and terrestrial **habitats.** A stress from human activity that affects the immediate environment may also affect an area downstream. Small impacts added over time or space may exert an additive effect. Therefore, EPA has adopted a more comprehensive approach by studying problems in the natural environment. The natural unit of study is the **watershed**, the area drained by a river system.

To gain a better understanding of ecological conditions in a watershed, it is important to look at how past events affected current conditions. In highly impacted areas, the environmental problems are not simply the consequence of recent activities but may be the accumulation of many decades or one or two centuries of impacts. For example, in New Bedford the current conditions are a complex mix of impacts accumulated over more than two centuries. By looking at these cumulative impacts, we can begin to understand what happened and why.

Historical studies are important for a number of reasons. Historical studies enable us to see the connection between land use and environmental conditions. Historical studies help us appreciate that some decisions can cause long-term environmental consequences. Historical studies are useful in planning **remediation** projects. Environmental scientists and managers can identify what impacts are irreversible and therefore, get a better idea of what is possible to remediate. Historical studies have become a component of environmental litigation, especially since the passage of **Superfund** legislation. Industries responsible for contamination are identified so clean up costs can be recovered. Finally, historical studies are a good educational tool: as background information for environmental scientists and managers; to get citizens interested in local environmental issues; to build ties between the community and scientists, and can be used as topics of interdisciplinary (e.g. science, history, writing) studies in middle schools and high schools.

What can we learn from historical studies? Historical records can help identify past pollutant inputs. For example, the Sanborn Insurance Maps show the location of industries as early as 1888. Local histories, especially those published by the board of trade or other commercial organizations, and the town and city directories provide information on industries as early as the mid-1800s. The types of pollutants produced by older industrial processes are listed in a number of books and journal articles.

Historical studies can be used to determine modification or loss of habitat. By comparing shorelines and wetlands on older maps with those on current ones, we can determine where wetlands and shallow areas have been filled and those important habitats lost. Changes in water circulation patterns and sediment deposition, which can modify **benthic** habitats, can be identified by examining old engineering surveys and by comparing older **hydrographic** maps to current ones.

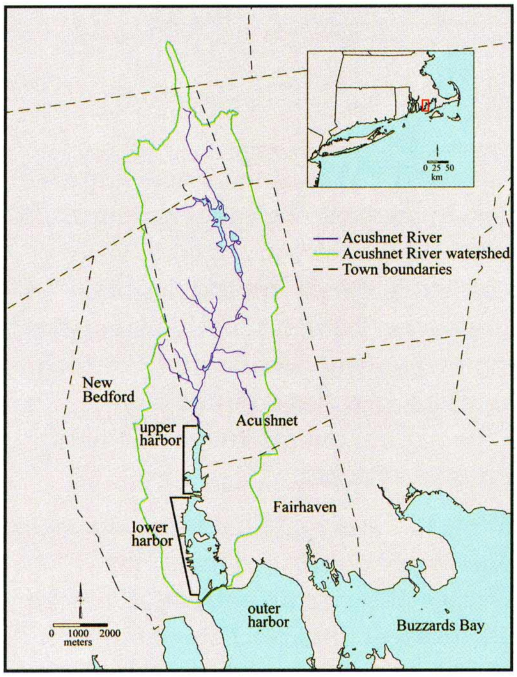


Fig. 1. New Bedford Harbor, the estuarine section of the Acushnet River, is located in southeastern Massachusetts. The Acushnet River watershed encompasses sections of the city of New Bedford, and towns of Fairhaven and Acushnet, plus small sections of three other towns.

Historical records may help identify changes in **species composition** or abundance. Comparisons of current biological surveys with older records kept by boards of health, shellfish wardens, and naturalists may indicate changes.

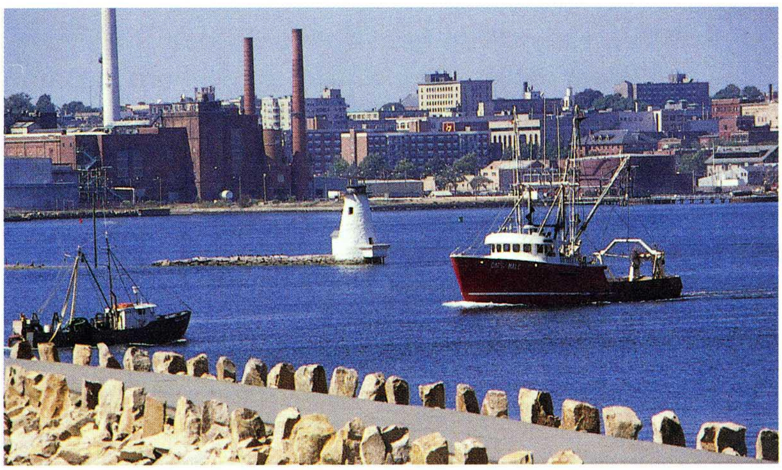
Acushnet River Watershed

The Acushnet River watershed is located in southeastern Massachusetts. New Bedford harbor, which is the lower **estuarine** section of the Acushnet River, empties into Buzzards Bay. The watershed includes part of the city of New Bedford and part of the towns of Fairhaven and Acushnet (Fig. 1).

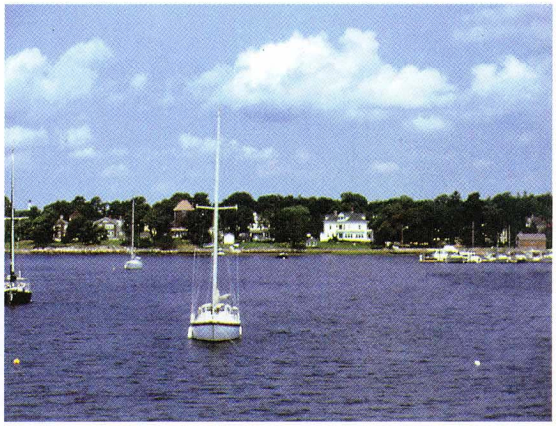
This watershed is the most urbanized area in the Buzzards Bay drainage basin and New Bedford Harbor is the most contaminated area in the drainage basin. The harbor is contaminated with metals and **organic compounds**, including **polychlorinated biphenyls**, commonly known as PCBs. Because of the high concentrations of PCBs in the sediment, the harbor was listed as a Superfund site in 1982. Dredging of the most contaminated sediments in the harbor has been completed; the second phase of the project, dredging more PCB-contaminated sediment, is planned. The harbor sediments also contain high concentrations of metals, particularly copper, chromium, lead, and zinc.

The city of New Bedford, with a population of about 100,000 is the commercial and population center in the watershed. The city is known for its history as a prosperous whaling port and later as a producer of fine

Photographs of the New Bedford waterfront: docks with fishing boats, brick buildings that were formerly textile mills, and a variety of commercial buildings. Photographs by Carol Pesch.



Marshes line the eastern side of the upper harbor (Acushnet). Photograph by Carol Pesch.



The Fairhaven waterfront is lined with residential areas (above) and commercial sections, primarily marine service and repair businesses (below). Photographs by Carol Pesch.

textiles. After the decline of the textile industry, New Bedford became known as a major commercial fishing port. Throughout New Bedford's history, the harbor has been the central feature of development and economic prosperity. The waterfront reflects current and past industries. It is lined with docks, storage and repair facilities, fish processing and packaging plants, large brick buildings that were formerly mills, and other commercial buildings.

The towns on the eastern side of the harbor are smaller and less commercialized; Fairhaven has a population of about 16,000 and Acushnet about 10,000. In the upper harbor there is a dramatic contrast between the industrialized New Bedford side and the marshes that line the Acushnet shore. In Acushnet, one industry is located on the waterfront at the top of the upper harbor while marshes extend along the rest of the shore. Residential areas are situated on uplands behind the marshes. In Fairhaven, the waterfront is lined with residential and commercial sections. The waterfront of the central business district is dominated by marine service and repair businesses that supply the fishing fleet and recreational boats.

History of the Watershed and Effect on Ecology

The settlement time in the watershed can be divided into four periods: agricultural (1650–1780), whaling (1750–1900), textile (1880–1940) and post-textile (1940–present) which includes commercial fishing and a variety of industries. The dates of these periods are approximate and overlap, but are useful to define the major ecological effects. As we look at the history of the watershed, we will see that development was driven by the desire of the local population to succeed economically. In the whaling and textile periods, development was often influenced by individuals or families that controlled the major businesses and banks. Events and economic conditions at regional and national levels also affected economic development, often in negative ways.

Agricultural Period: 1650–1780

Gosnold at Smoking Rocks, 1842, William Allen Wall. This painting depicts Bartholomew Gosnold landing at Smoking Rocks in 1602. Smoking Rocks was located on the New Bedford coast opposite Palmer Island, which is just north of the hurricane barrier. *New Bedford Whaling Museum collection.*

Native Americans were the first inhabitants of the watershed. Bartholomew Gosnold reported the presence of a large native population when he visited the area in 1602. Native Americans probably hunted in the wooded inland areas, planted crops on the flat land along the coast, and utilized the abundant marine resources found in the **estuary**: fish, shellfish, birds, and marine mammals. The coast was also the site of trade with the Europeans. Gosnold exchanged European goods for native furs.

The earliest Europeans settled in the watershed in the mid-1600s. These first settlers were mostly Quakers who emigrated from Portsmouth, Rhode Island and Plymouth and Taunton, Massachusetts. No exact population counts of these first settlers are available, and many of the original houses were destroyed during King Philip's War, the Anglo-Native American conflict that ended in 1676. By 1690, 11 to 13 families owned land in the area of present-day New Bedford (Fig. 2). At this time, Joseph Russell owned a parcel of land in the area of what was to become the center of New Bedford's waterfront district. The Russell family played an important role in the development of New Bedford.

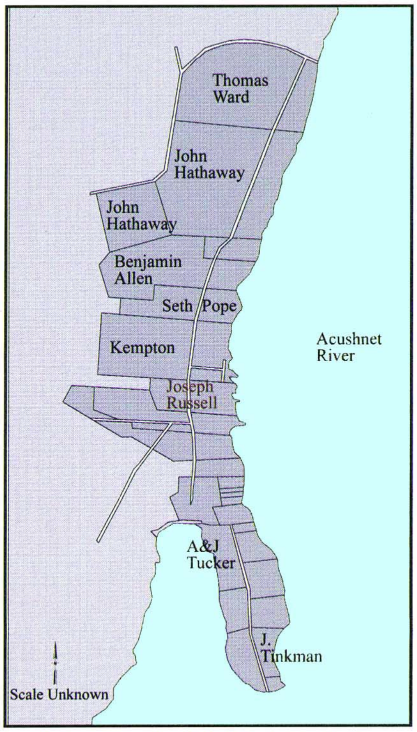


Fig. 2. Land ownership in New Bedford in 1690, taken from a map made by Henry Worth from data and survey by Benjamin Crane, circa 1711. (Old Dartmouth Historical Sketch No. 15, Story of Water Street, by Elmore P. Haskins)

These early settlers were primarily subsistence farmers. They cleared the land, planted crops, and kept livestock. They probably also fished. The effect of these early settlers on the landscape and harbor was probably minimal because the population was low. Recent studies on the effect of land-clearing in watersheds of some Chesapeake Bay tributaries found that greater than 20

The Apponegansett Meeting House, shown in this photo taken in 1922, was built in Dartmouth by Quakers in 1790. It replaced an earlier meeting house built in the same location in 1699. *New Bedford Whaling Museum collection.*

percent of the watershed must be cleared before there is enough erosion to cause an increase in sedimentation rates in an estuary. Using the number of families present in the Acushnet River watershed by 1771 and the size of the typical New England colonial farm, we estimated that about four percent of the watershed had been cleared by that date. However, in the whaling and textile periods more land was cleared for commercial, industrial, and residential use and the effects of land-clearing (change in stability and filtering capacity of soil, increased erosion, increased input of sediment and nutrients into the estuary) undoubtedly occurred then.

Haying on the Acushnet, **circa 1850, William Allen Wall. This painting, depicting an agricultural scene, is interesting because it shows farmers utilizing the salt marsh grass along the Acushnet River. *New Bedford Whaling Museum collection.***

Whaling Period: 1750 - 1900

By the mid-1700s, the economy in both New Bedford and Fairhaven began to shift to maritime-related activities: whaling, shipbuilding, and extensive import/export trading. The first locally owned whaler shipped out of New Bedford in 1755. This whaler was owned by Joseph Russell, a descendent of the Russell family who acquired land in New Bedford in the last quarter of the seventeenth century. Five years later, Joseph Russell sold portions of his homestead to a boat-builder, a blacksmith, a cooper, a cordwainer, and a house carpenter. All these professions supported whaling, and their presence in New Bedford stimulated the growth of the whale industry. In essence, Russell functioned as the first planner for New Bedford.

In 1765, Joseph Rotch, a senior member of an established Nantucket whaling firm, arrived in New Bedford and purchased land from Joseph Russell. Rotch brought with him money and expertise to advance the whale fishery. Within 10 years, there were 40 to 50 whaleships registered in New Bedford. The families of Joseph Russell, Joseph Rotch, and Samuel Rodman, Rotch's son-in-law, dominated the economic development of New Bedford. In addition to owning whaling vessels, they were involved in outfitting whaling vessels and in the manufacture of whale oil products.

Although the British burned part of New Bedford in 1778, during the American Revolution, the maritime economy was well enough established that the town was rebuilt. By 1780, there were developmental centers on either side of the Acushnet River. On the western side, the site of initial development was located in what is now the historic district of New Bedford. On the eastern side, there were two developmental centers, Fairhaven village and Oxford village (Fig. 3). Shipbuilding, whaling, and related businesses developed in both villages.

In 1798, William Rotch, a successful businessman in the whaling industry, and several

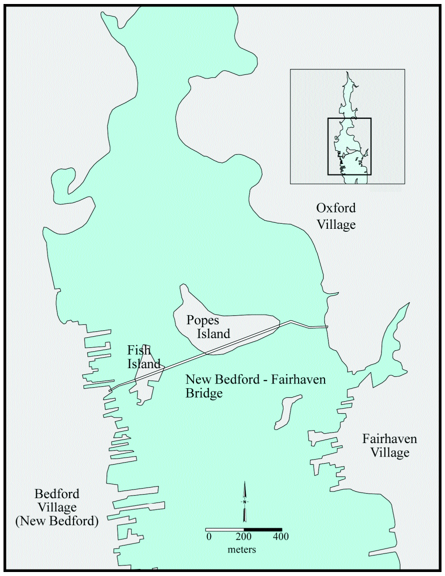
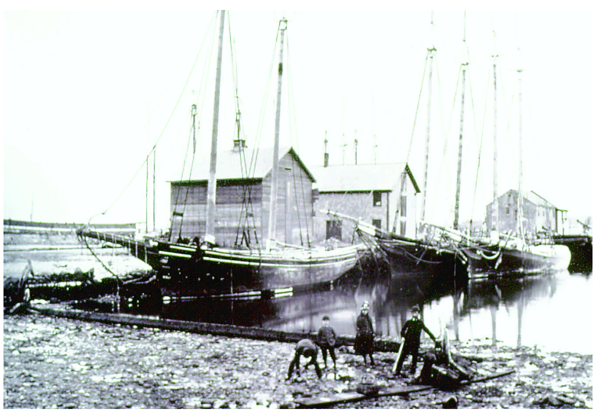


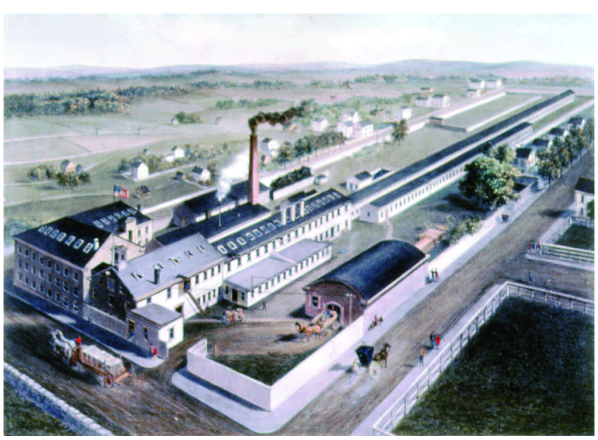
Fig. 3. The New Bedford - Fairhaven Bridge, built in 1798 to connect the villages, altered currents and sedimentation patterns in the harbor and as a result affected the pattern of development in the area. The coastline shown in this figure is from a map of the Town of Fairhaven, 1855, surveyed by H. F. Hatting.

other businessmen, built a bridge connecting the east and west side of the river to improve commercial ties between New Bedford and Fairhaven and Oxford villages (Fig. 3). The bridge had a major effect on the pattern of development in the watershed. It altered the currents in the river and caused sediment to accumulate along the east shore at Oxford village, north of the bridge, and thus curtailed further development of this area as a port and shipbuilding center. Maritime activities continued at Fairhaven village, located south of the bridge, but physical expansion of the village was limited because the owner of the adjacent farm refused to sell until the 1830s. As a result, New Bedford, on the west side of the Acushnet River, became the commercial center for the river.

The economic consequences of the Revolutionary War, the Embargo in 1807, and the War of 1812 adversely affected whaling and related businesses. The British Royal Navy blockaded the American coast during the wars. The embargo halted all trade with Europe. The whale fishery, which was idle during much of this time, flourished after the end of the War of 1812. By 1820 New Bedford had taken the lead in whaling from Nantucket. This boom in the whaling industry was accompanied by an increase in related businesses: whale oil processing, candle and soap-making, shipbuilding, barrel-making, sail-making, rope-making, machine shops, and foundries. Some of the companies established during this time remained in business for more than a century. New Bedford Cordage Company, established in 1842, was in operation until 1964. New Bedford Copper, incorporated in 1860, produced copper sheathing for the bottoms of ships. The company, later bought by Revere Copper and Brass, still operates in New Bedford. W. F. Nye Oil Factory, established on Fish Island in 1866, processed oil from small whales called blackfish. This oil was highly prized for lubricating watches, clocks, and chronometers.



Schooners at Old South Wharf, Fairhaven, circa 1890, Henry P. Willis. The wharf was built about 1710, when it was home to cooper shops, a newspaper, bakery, and shipyard. ***New Bedford Whaling Museum collection.***



New Bedford Cordage Company, circa 1860, hand colored lithograph by J. P. Newell, printed by J. H. Bufford. ***New Bedford Whaling Museum collection.***

The firm moved to Fairhaven by 1940 and is still in business today as Nye Lubricants, a manufacturer of lubricating oils and grease.

Environmental Impact of the Whaling Period

The growth of the whaling industry brought changes to the shoreline of the Acushnet River (Fig. 4). Maps of the New Bedford coastline showed no wharfs prior to 1800. By 1855 numerous wharfs had been constructed in the area just north and south of Fish Island. Some were solid-walled structures of stone and logs filled with dirt, while others were platforms supported by pilings. Fish Island, also an area of commercial activity, had increased considerably in area by 1855.

A harbor survey conducted by the Army Corps of Engineers in 1853 found that the wharfs in New Bedford and on Fish Island, and the New Bedford-Fairhaven bridge had changed the **hydrographic** properties of the river. The bridge and wharfs constricted the channel between the New Bedford coastline and Fish Island and reduced the volume of water passing through this channel during tidal exchanges. As a result, sediment accumulated along the shoreline in front of the wharfs. Comparison of nautical charts from 1780 and 1844 shows a six-foot decrease in water depth along the New Bedford side. The constriction in the channel between the shore and Fish Island caused more water to flow through the channel between Fish Island and Popes Island. This increased flow washed away mud and sand in the channel between the islands. The construction of wharfs, the accumulation of sediment around the docks and in channels, and subsequent dredging, impacted the shellfish beds and

New Bedford was a thriving whaling center as seen in this photo, taken about 1870, of its waterfront. *New Bedford Whaling Museum collection.*

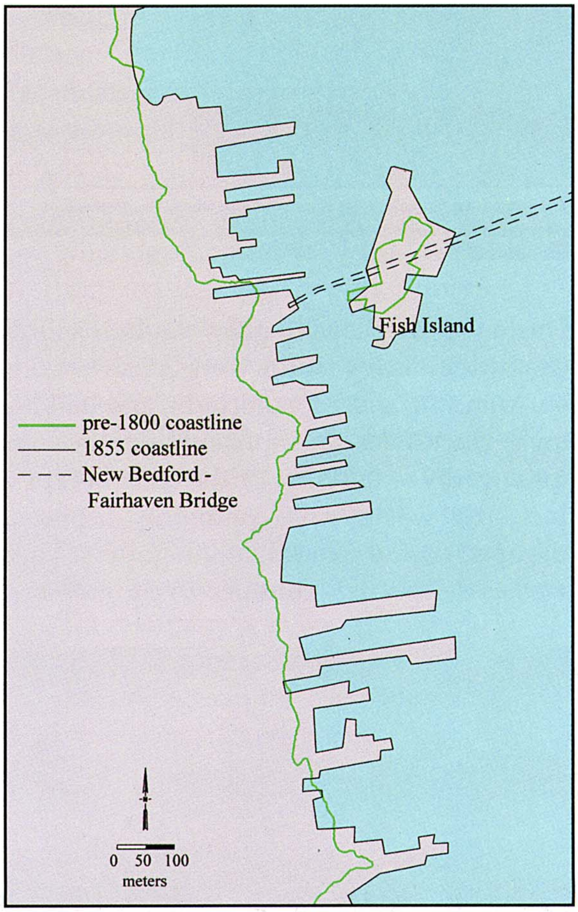


Fig. 4. The coastline in 1855 (surveyed by H. F. Hatting) shows that a considerable number of wharfs were built and some land gained since before 1800 (coastline from map of Original Purchasers of lots in New Bedford, 1753 to 1815, E.C. Leonard) when no wharfs were present.

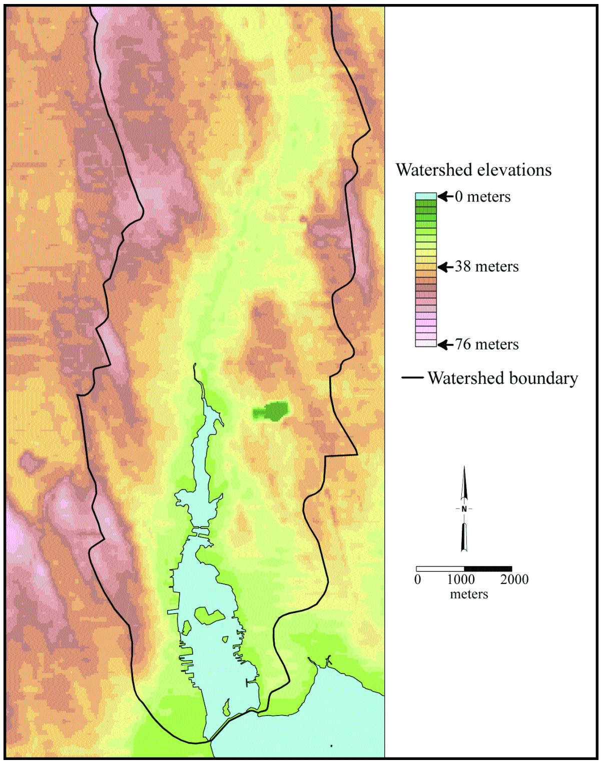


Fig. 5. Topographic map of the watershed area shows the north-south ridgeline in New Bedford. Run-off from land east of the ridgeline flows into the Acushnet River.

benthic communities in the vicinity.

In comparison, the changes in the shoreline on the Fairhaven side were minimal. Nevertheless, sediment that collected in the channel between Popes Island and the Fairhaven shore restricted shipping activity north of the bridge.

An important physical feature of a watershed is its **topography**. New Bedford is built on a hill. The north-south ridgeline is obvious on a topographic map (Fig. 5). Most of the early development in New Bedford occurred to the east of the ridgeline, along the shoreline and extending up the hill. The street grid was set up with thoroughfares extending in a north-south direction, parallel to the waterfront; streets perpendicular to those ran in an east-west direction. In contrast, the Fairhaven side is relatively flat.

How did the topography affect conditions in the harbor? Any contaminants in the soil or dumped on streets on the east side of the ridgeline would have washed down hill toward the water. During the whaling period, human waste was disposed in privy vaults, shallow holes or stone-lined holes underneath a privy (outhouse). Privy vaults were constructed either to be **permeable**, and leaked into the surrounding soil, or watertight, and had to be emptied periodically. Carts were used to carry away the wastes, and spillage from the carts was inevitable. The carts were commonly emptied into nearby waterways or the contents spread on farmland outside of town. During this time, industrial wastes were commonly disposed of in streams or adjacent waterways and sometimes dumped on the ground and in gutters. The east-west streets sloped towards the river and any wastes deliberately dumped in a gutter or spilled on a street would wash down into the river.


New Bedford from Fairhaven, circa 1845, William Allen Wall. The hill in New Bedford is beautifully illustrated in this painting. *New Bedford Whaling Museum collection.*

More importantly, topography affected how the sewer system was constructed. Enough growth had occurred in New Bedford by the mid-1800s that the first sewer lines were installed in 1852. These early sewer lines ran along selected east-west streets and emptied directly into the Acushnet River. (Fig. 6). Industries and houses on the west side of the ridge dumped their wastes into Tripp's Brook, which emptied into Clarks Cove. A few of the early sewer lines also emptied into that brook. Eventually Tripp's Brook was enclosed in an underground pipe and incorporated into the sewer system.

Centre Street, circa 1890, photographer unknown. This view down Centre Street, New Bedford, shows the slope down the hill to the harbor. *New Bedford Whaling Museum collection.*

The growth of the whale fishery brought increases in related businesses, which had an impact on the environment. Industries were concentrated in what is now the historic section of New Bedford, with most situated along the coastline (Fig. 6). Only businesses that used or produced chemicals that might have contaminated the environment, or businesses of historical interest, such as whale oil processors, are included on this map. During the whaling period, there were many whale oil processors, firms that refined whale oil for use in lamps or as lubricating oils, or made candles and soap. Whale oil processing firms were not major polluters, but may have released biological wastes, lye, and caustic cleaning solutions into the environment. These firms also may have emitted **polycyclic aromatic hydrocarbons** (PAHs) from wood and coal combustion, and arsenic and mercury from coal combustion.

Many whaling-related industries worked with metals. Foundries, machine shops and casting, plating and metal-working businesses provided the metal goods needed for whaling: copper sheathing for the bottoms of ships, try pots, pumps, fittings, and ship bells. Potential pollutants from these industries include metals, solvents, oils and grease, and acids. Although many of these metal business were small shops, there were a few larger ones. The largest, New Bedford Copper Company, located on the waterfront in New Bedford in 1860. The company was bought out by Revere Copper and Brass in 1928, and still operates in the city. Other industries, including tanneries, print shops, coal gas production, and manufacture of paint and varnish, glass, and chemicals, may have released acids, cyanide, petroleum hydrocarbons, phenols, metals, solvents, and biological wastes into the environment.

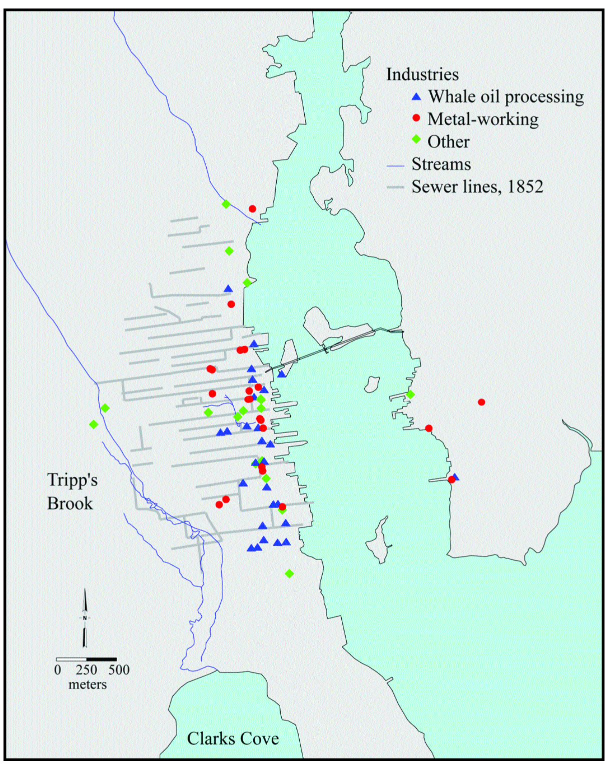
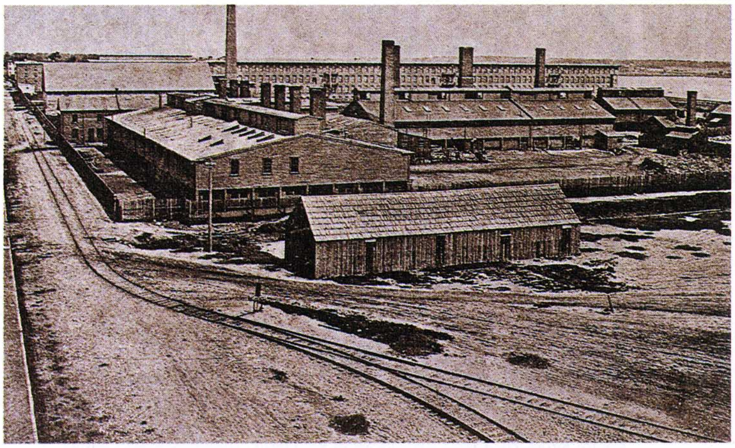


Fig. 6. During the mid-nineteenth century, industries located along the coast in what is now the historic section of New Bedford. Most industries not directly on the shore or a stream had access to the sewer system, which was installed in 1852. Sewer lines were located on east-west oriented streets and emptied directly into the harbor.

Most industries not directly on the coast had access to a sewer line or were located adjacent to a stream.

In contrast, there were few industries in Fairhaven, on the eastern side of the Acushnet River. One long-standing business in Fairhaven was American Nail Machine Company, which moved there from Boston in 1866. After it was bought out by a group of New Bedford businessmen, it was renamed American Tack Company, and later became Atlas Tack Company. By 1875, this nail and tack producing company dominated Fairhaven's manufacturing economy. Potential pollutants from this metal-working industry included metals, solvents, oils and grease, and acids.



New Bedford Copper Company, circa 1895, photographer unknown. *New Bedford Whaling Museum collection.*

American Tack Company, Fort Street, Fairhaven, circa 1868, photographer unknown. *Courtesy of the Millicent Library, Fairhaven*

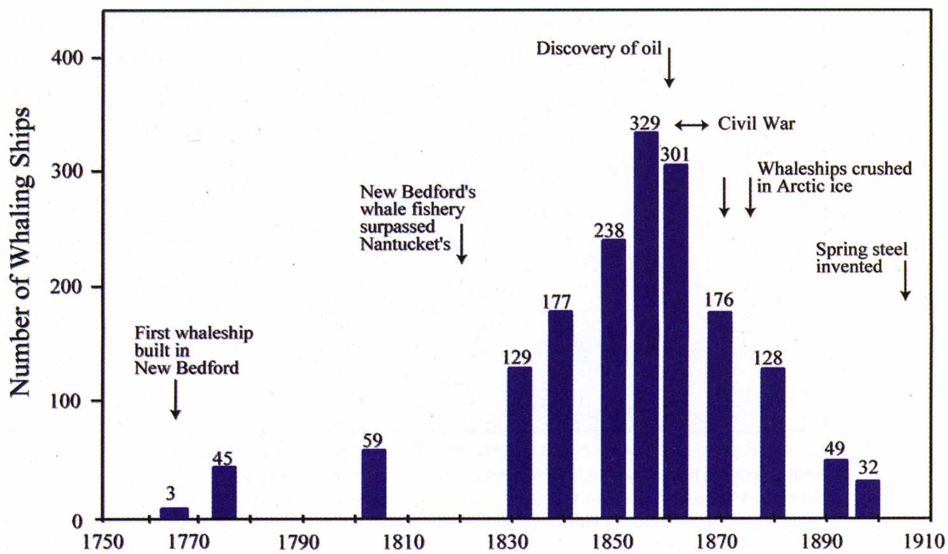


Fig. 7. Whaling reached its peak in 1857, when 329 whaling ships were registered in New Bedford.

Decline of Whaling

Abandonment of the Whalers in the Arctic Ocean, September, 1871, Benjamin Russell, J.H. Buffords Lith., Boston, 1872. *New Bedford Whaling Museum collection.*

Whaling reached its peak in 1857, when 329 whaling ships listed New Bedford as home port (Fig. 7). Anumber of events influenced the decline of whaling. In 1857, a nationwide depression caused prices of whale oil to drop. Recovery of the whaling industry was compromised by the discovery of petroleum in Pennsylvania in 1859, which eventually eliminated the need for sperm and whale oil for illuminants. Then, events during the next 20 years led to the loss of many whaleships. During the Civil War (1861-1865), 24 whaleships from New Bedford, part of the so-called "stone fleet," were filled with rocks and sunk at the entrances to Charleston and Savannah harbors to block the ports. In addition, more than 28 whaleships from New Bedford were stopped and burned by Confederates raiders. As the price of whale oil dropped, the price of **baleen** rose more than 100 percent. The whaling fleet traveled to the Arctic to hunt Bowhead whales for their baleen. The Arctic was a dangerous place to hunt whales. In 1871 and 1876, 45 whaleships were trapped and crushed in the Arctic ice.

By the early 1900s the use of spring steel and other products to replace baleen put an end to the baleen market. The last square-rigged whaleship to leave New Bedford Harbor was the *Wanderer,* which was wrecked off Cuttyhunk Island in August, 1924. However, the end of whaling was not the end of New Bedford's connection to the sea. The fishing industry was active during the second half of the nineteenth century and beginning of the twentieth century, but New Bedford didn't become a major fishing port until the 1940s.

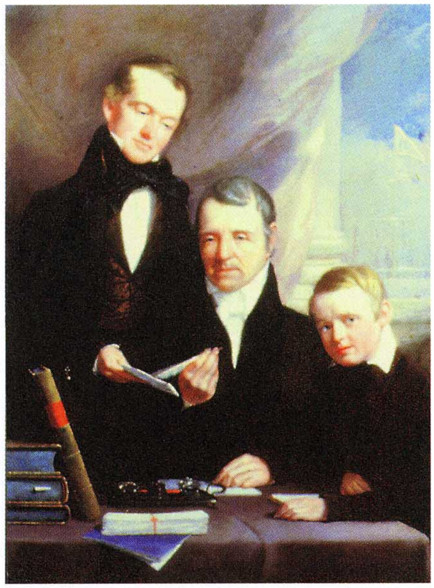
At right, Wreck of the *Wanderer*, August 24, 1924, Albert Cook Church. The *Wanderer,* the last square-rigged whaleship to leave New Bedford, was wrecked off Cuttyhunk Island. *New Bedford Whaling Museum collection.*

Textile Period: 1880-1940

Because the whaling industry generated large amounts of capital, there was little interest in New Bedford to venture into other businesses. New Bedford's economy was dependent primarily on whaling and whaling-related businesses. By 1850 the textile industry was well established in nearby Fall River and other towns in Massachusetts, but was just beginning in New Bedford. In 1846, two prominent whaling men, William Rotch and Samuel Rodman, and several other investors financed the New Bedford Steam Cotton Mill, which operated for only two years before moving out of the city. The Wamsutta Mill, opened in 1848, was the first successful textile mill in New Bedford. Because of the continued prosperity of the whaling industry it was another 30 years before the boom in the textile industry took place in New Bedford (Fig. 8).

With the decline of whaling in the 1880s, profits from the whaling industry were used to finance textile mills. A handful of prominent families controlled the financial resources in New Bedford. These families were involved in the whaling industry, the banks, and later, the textile industry. Therefore, decision-making was controlled by the same small group of people during both the whaling and textile periods. The Howlands are an example of a New Bedford family that ran a successful whaling business and later invested in textile mills.

Wamsutta Mills, circa 1853, William Allen Wall. This painting of the first successful textile mill in New Bedford links the past, the agriculture scene in the foreground and whaleships in the distant harbor, with what was to become the future, the development of the textile industry. *New Bedford Whaling Museum collection.*



George Howland and Sons, circa 1840, William Allen Wall. George Howland and his sons, George Jr. (left) and Robert, sit in the counting room where the family managed one of New Bedford's largest whaling fleets. *New Bedford Whaling Museum collection.*

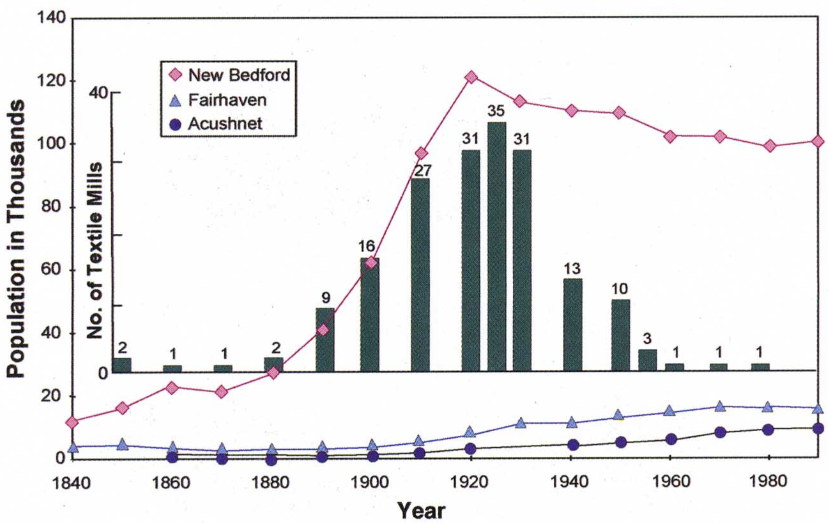


Fig. 8. From 1880 to 1920, the population in New Bedford increased more than four-fold as the textile industry expanded. In contrast, the population of both Fairhaven and Acushnet was much smaller.

Engine House, 1871, lithograph by the New England Lithograph Company, from a drawing by H.W.P. The supply of water from the Municipal Water Works, which was put in operation in 1869, made expansion of the textile industry in New Bedford possible. *New Bedford Whaling Museum collection.*

Textile mills needed a good supply of water to operate. The Municipal Water Works, developed in New Bedford in 1869, insured a good supply of water and made expansion of the textile industry possible. The abundant supply of water also permitted owners of private residences to install water closets (toilets) in their homes. This new convenience quickly caused health problems. In houses not on a sewer line, water closets were connected to cesspools, which frequently overflowed because of the increased flow of piped-in water.

As the labor-intensive textile industry expanded, there was a dramatic increase in population in New Bedford (Fig. 8), from about 27,000 in 1880 when there were two mills, to about 121,000 in 1920 when there were 31. The number of mills peaked at 35 in 1925. In contrast, the increase in population in Fairhaven and Acushnet during this same period was much lower.

Many of the new residents in New Bedford were foreign-born. By 1910, 44 percent of the total population of the city was foreign-born. Many immigrants came from Canada (especially French Canadians), England, the Azores and Cape Verde Islands, Portugal, and Ireland. Fewer numbers of immigrants came from other countries, such as Austria, Russia, Germany, Scotland, and Poland. The influx of people, many foreign-born, changed the population of New Bedford from a close-knit community where many families were related by marriage, to a more culturally diverse community.

Immigrants Arriving on the *Savoia,* October 5, 1914, Edmund Ashley. From the turn of the century to the 1930s, Cape Verdeans were among the immigrants who came to New Bedford. *New Bedford Whaling Museum collection.*

Environmental Impact of the Textile Period

What was the impact of the textile mills on the environment? The major source of pollution from textile mills is waste water from bleaching and dyeing processes. However, most New Bedford mills just spun thread and wove cloth, they did not finish the cloth. (There were a few dye houses in New Bedford and the impact of these will be discussed below.)

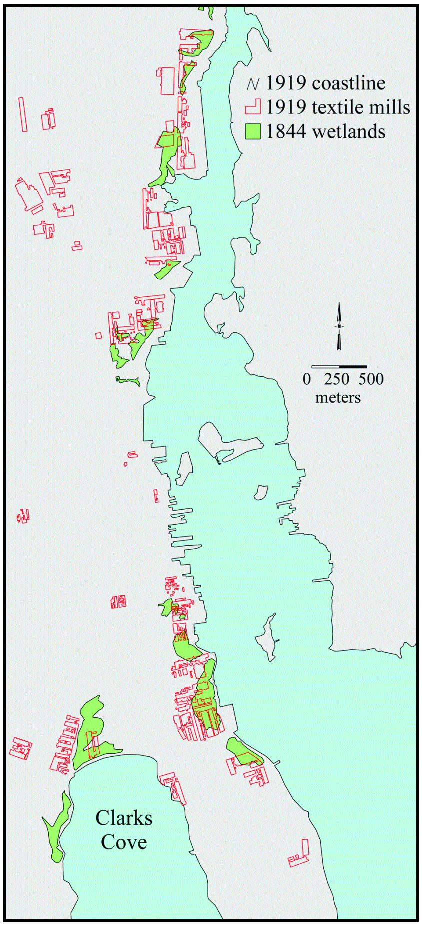


Fig. 9. The New Bedford textile mills, shown here in 1919 (Commission on Waterways and Public Lands of Massachusetts, 1919) were built on the wetlands, shown on a 1844 map (U.S. Coast and Geodetic Survey, 1844), to the north and south of the central business district.

The ecological impact of the mills was where they were located. They were built on the relatively cheap wetlands along the west shore of the Acushnet River, north and south of the central business district, and also at the head of Clarks Cove (Fig. 9). Construction of the mills led to a loss of 134 acres of wetlands, including almost all those along the west side of the Acushnet River.

Spinning Room, Nashawena Mill, circa 1924, photographer unknown. *New Bedford Whaling Museum collection.*

At the time some of these mills were built, residents probably thought filling in wetlands was good. Until the 1890s, the filth theory of disease transmission was widely accepted. According to that theory, diseases were caused by impure air generated by putrefied organic material, including human and animal excrement, rotting garbage, and vapors from swamps and stagnant pools. The filth theory was the basis of the 19th-century Sanitary Movement, which emphasized the importance of emptying cesspools and privy vaults, collecting garbage, cleaning streets, and filling in wetlands to eliminate sources of impure air.

Why are wetlands important? Wetlands filter pollutants, excess nutrients, and harmful microorganisms; provide habitat for resident and migratory species; serve as nursery areas for aquatic species; and provide erosion control for the shoreline. These functions are lost when wetlands are filled.

Triple-decker houses on Bolton Road, New Bedford, 1907, photographer unknown. *New Bedford Whaling Museum collection.*

The biggest impact of the textile period on the environment was the dramatic increase in population. People were needed to work in the mills. Expansion of the city took place around the mills, as houses, many of them triple-deckers, were built to house mill workers. The increase in population meant an increase in the amount of waste to remove. The sewer system was extended. The initial sewer lines had been installed in the central business district. Expansion of the sewer system followed the growth of the city to the west, north, and south of this central district. All sewer lines emptied directly into the Acushnet River or Clarks Cove. Removing wastes by dilution in rivers was an acceptable practice at this time.

The Sewer, 1914, Clifford W. Ashley. This painting depicts the sewer at the foot of Union Street, New Bedford, emptying into the Acushnet River. *New Bedford Whaling Museum collection.*

By the end of the nineteenth century, the amount of sewage entering the harbor at the end of the streets became a problem in some places. In areas of weak current flow, solid material accumulated at the end of sewer pipes, making it difficult to use some docks because of decreased water depth and creating a **nuisance** with the bad odors. Sewage caused more than just a nuisance. Sewage is a public health hazard. By the 1890s, bacterial researchers had shown that the germ theory, which states that bacteria cause diseases, was correct. Sewage contaminated the water and shellfish in New Bedford Harbor. There were 565 cases of typhoid fever, with 93 deaths, reported in New Bedford from 1900 to 1903. Bacterial researchers at the Massachusetts State Board of Health Lawrence Experiment Station determined that typhoid fever was caused by the consumption of shellfish contaminated with the bacteria found in sewage.

In 1904, the State Board of Health closed the Acushnet River and Clarks Cove to shellfishing (Fig. 10). In 1912, construction began on an interceptor sewer line to divert sewage into Buzzards Bay off the tip of Clarks Point (Fig. 10). The interceptor line was only partially completed, five of nine pumping districts were connected, when work stopped in the 1920s and did not resume until 1947. Even when the interceptor line was completed, it did not completely stop untreated sewage from emptying into the harbor. The sewer system was, and still is, a combined one: storm run-off empties into the same pipes as domestic and industrial wastes. In periods of high rain, the pipes are not large enough to handle the volume and some sewage enters the harbor at various points through the **combined sewer overflows** (CSOs). The Acushnet River has remained closed to shellfishing since 1904.

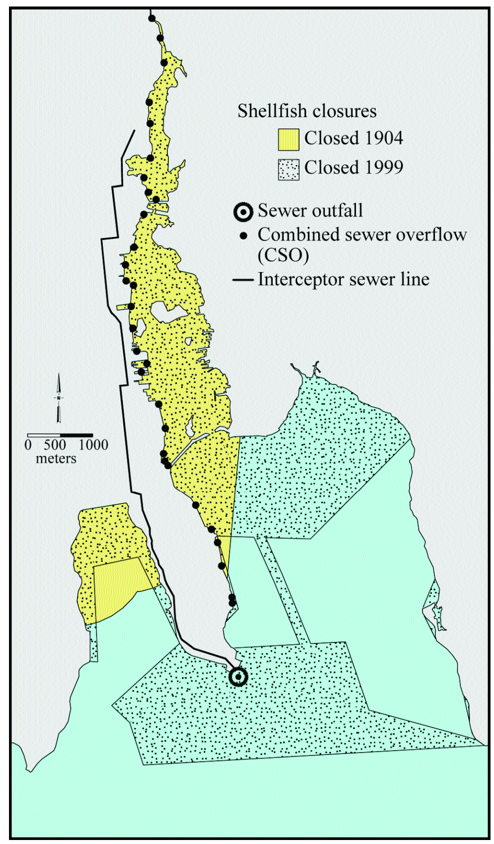


Fig. 10. The State Board of Health closed the Acushnet River to shellfishing in 1904 and that section has remained closed since then. Raw sewage still enters the harbor through combined sewer overflows (CSOs) during periods of high rainfall. Additional areas in the outer harbor were closed after the interceptor sewer line diverted the outfall off Clarks Point. On this map, the four classifications for shellfish closures for 1999 were collapsed into two groups: open (approved and conditionally approved) and closed (prohibited and restricted).

Modern studies at sewage outfalls have demonstrated that sewage causes a number of environmental problems: high amount of organic carbon, increased nitrogen, low

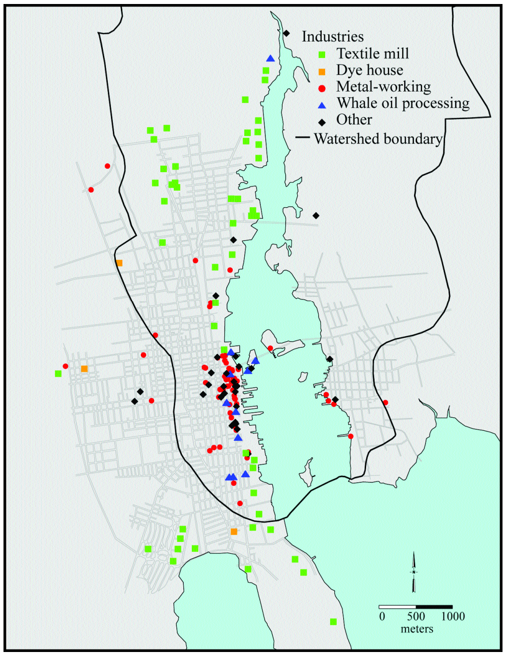


Fig. 11. Location of industries that may have released pollutants during the textile period (1880 - 1940).

oxygen concentrations, low species **diversity**, and increased numbers of **opportunistic** species. The presence of large amounts of sewage in New Bedford Harbor from the late 1800s on is well documented, and we can assume that during the textile period and later, sewage caused ecological effects in the harbor. Recent studies in New Bedford confirm these effects. They found high concentrations of organic carbon in the upper harbor, and benthic communities with low species diversity and increased numbers of opportunistic species.

What other industries may have impacted New Bedford Harbor during the textile period? Figure 11 shows the industries located in the watershed during this time that were likely to release pollutants. Textile mills are included, although they were not major polluters. There were a few dye houses in New Bedford, however, only one is located within the watershed boundary. They released bleach and dyes, which contained metals and petroleum hydrocarbons. As in the whaling period, there were many industries that used metals: foundries, machine shops, and casting, plating, and metal-working companies. There were a few soap-making companies left, but most were gone by the turn of the century. The other industries depicted here - oil refining, tanning, glass-making, paint manufacturing, printing, and production of coal gas, rubber products and electricity - were possible sources of metals, acids, petroleum hydrocarbons, phenols, cyanide, solvents, and biological wastes.

In contrast, there were relatively few industries in Fairhaven. After the whaling industry collapsed, investors in Fairhaven unsuccessfully attempted cotton manufacture. The Acushnet Mill, built in 1843, was closed by 1850 and Fairhaven Iron Foundry took over its buildings in 1862. American Tack Company (later named Atlas Tack) and several shipyards also supplied jobs in Fairhaven.

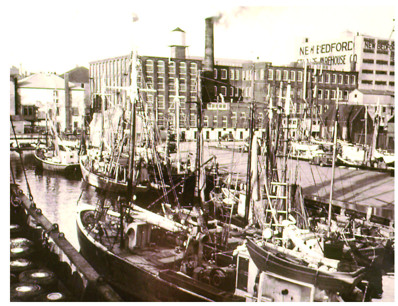
Fairhaven Iron Foundry, photograph from *A Brief History of Fairhaven* by J. L. Gillingham. *Courtesy of the Millicent Library, Fairhaven.*

In 1902, Atlas Tack Company moved from its original location on the shore of the harbor to its present location on Pleasant Street, just outside the boundary of the Acushnet River watershed. The company contaminated the ground around the site with metals, PAHs, PCBs, cyanide, DDT (a pesticide), and toluene (a solvent). In 1990, Atlas Tack was listed as a Superfund site. Contaminants from the site are transported by surface run off and ground water into a small creek that enters Buzzards Bay. Although Atlas Tack is outside the watershed, the section of Buzzards Bay, just south of the hurricane barrier, where the contaminants drain is considered part of the New Bedford Harbor Superfund site. However, the plant has not discharged wastes for more than 20 years, and now any contamination that reaches Buzzards Bay is mostly diluted. The building and surrounding grounds were named a Superfund site and are scheduled to be remediated.

Decline of the Textile Industry

The popularity of the automobile in the early 1900s created a need for yarn for tires and provided a very profitable market for mills in New Bedford. World War I fueled the demand for tire yarn and cloth for uniforms. Many mills in New Bedford switched from producing fine fabrics to coarser ones for the war effort. This put them in direct competition with the mills in the South, which typically produced coarse goods and had lower production costs. The number of mills in New Bedford peaked in 1925. Then, a number of factors contributed to the decline in textile manufacturing in the city. Some mills closed and moved south. In order to compete with the southern mills, mill owners in New Bedford cut workers' wages, assigned more machines to each employee, and tried to speed up the old machines. In response to these changes, workers in the New Bedford mills walked out on a prolonged strike, which further weakened the textile industry. The New Bedford mills were in poor economic shape when the stock market crashed in 1929 and set off the Great Depression in the early 1930s. Many mills closed.

Municipal Parking Lot, circa 1924, Joseph S. Martin. This view from City Hall, New Bedford, shows how popular the automobile had become by the 1920s. *New Bedford Whaling Museum collection.*

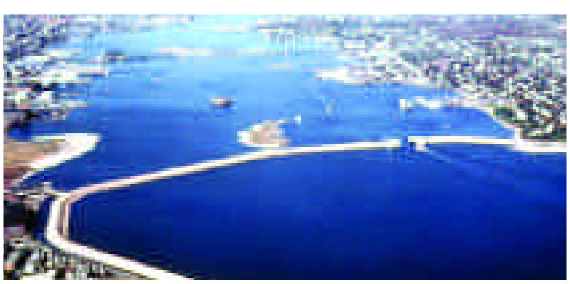


New Bedford fishing fleet in the 1930s. *New Bedford Whaling Museum collection*

Post-Textile: 1940 - present

What replaced the textile industry in New Bedford? Even before the industry's decline, commercial fishing had begun in New Bedford in the second half of the nineteenth century, but was limited because fishing boats depended on sails. Anumber of changes occurred in the beginning of the twentieth century that allowed commercial fishing to grow rapidly and expand into a major industry in New Bedford. In the first decade of the century, motors were put on fishing boats. With motorized boats, fisherman could get fresh fish to market. With expanded use of trucks to transport the catch, fishing boats could land the catch in New Bedford instead of New York. Modern refrigeration and the establishment of the first fish processing house in New Bedford in 1931 gave the fishing industry another boost. A freezer plant built in the 1940s added to the port's ability to process fish. The Port of New Bedford became a major fresh-fish processing center on the east coast, as well as the major scallop port on the northeast Atlantic coast.

The fishing fleet and other commercial facilities along the shore are subject to damage from storms and hurricanes. Losses were great during the hurricanes in 1938 and 1954. In 1965, the Army Corps of Engineers completed construction of a barrier across the harbor entrance to protect businesses and homes from storm damage. A 150-foot gateway permits passage of boats and water exchange between the inner and outer harbors. Gates close the gap in the hurricane barrier when storm surges are predicted.



In 1965, a hurricane barrier was built by the Army Corps of Engineers across the entrance of New Bedford Harbor to protect homes, business, and boats from storm damage. *Photograph courtesy of the Army Corps of Engineers.*

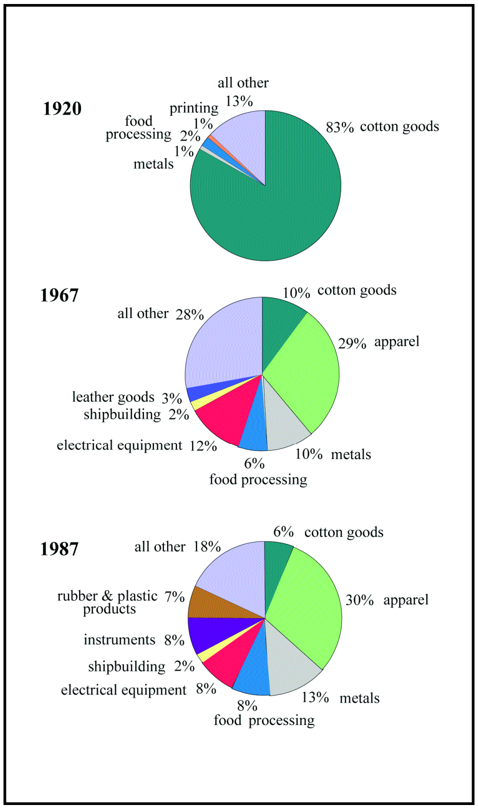


Fig. 12. The percentage of employees (calculated from Bureau of Census, Census of Manufactures data) in various manufacturing industries in New Bedford shows the diversification of manufacturing from 1920 to 1987. During this time, the actual number of employees in all manufacturing jobs decreased by about 50 percent, from 43,226 in 1920 to 20,100 in 1987.

Although a number of researchers have reported characteristics of the harbor after the hurricane barrier was built, only a few have addressed the possible effects of the barrier. One researcher reported an increase in sedimentation rates in some areas of the harbor inside the barrier. Another suggested that there was a reduction in exchange of water between the inner and outer harbors. Arecent preliminary modeling study, designed specifically to look at the effects of the barrier, showed an increase, by up to 30 percent, in the **water residence time.** The same modeling effort showed a change in water circulation patterns in the immediate vicinity of the hurricane barrier. The water forms a **gyre** north and south of the barrier at certain times during the tidal cycle. The north gyre could enhance mixing of incoming water and affect sedimentation patterns; the south gyre could recirculate water and wastes leaving the harbor, and part of this water could be swept back inside the barrier during the next incoming tide.

In an attempt to offset high unemployment, a series of city and private non-profit groups, active from 1929 through the 1960s, developed strategies to encourage new industries to relocate to New Bedford. They offered incentives such as moving expenses, a favorable tax strategy, and low rentals. They also extended a favorable community attitude toward manufacturers moving to New Bedford. The city, with its large empty factory spaces and large workforce with manufacturing experience and low pay scale, was attractive to manufacturers. Clothing manufacturers were a natural to occupy the empty mills. By the 1970s, they accounted for almost one-third of the manufacturing jobs in New Bedford. A number of other assorted manufacturing companies, including two electronic parts manufacturers, moved to the city. The diversification of industry in New Bedford is illustrated in Figure 12, which shows the percentage of workers employed in various categories of manufacturing.

Many of the new industries located in empty mill buildings. A few industries moved into the industrial park that had been built in the north end of New Bedford in 1960. Two electronic parts manufactures moved into empty mill buildings on the waterfront in New Bedford, Aerovox Corporation in 1939 and Cornell-Dubilier in 1941. Both of these companies used PCBs in the manufacture of capacitors, and discharged PCB-containing wastes directly into the surrounding waters and also through the municipal sewer system.

The presence of PCBs in New Bedford Harbor was first documented by academic and government researchers in the mid-1970s. Concentrations of PCBs in the river water far exceeded the **water quality criterion** designed to protect marine life. Concentrations of PCBs in sediments were also exceedingly high in some places in the harbor (Fig. 13). PCBs, which are persistent in the environment and potentially **toxic**, **teratogenic**, **mutagenic**, and **carcinogenic**, pose a health concern. The U.S. Environmental Protection Agency banned the sale of PCBs in 1978 and New Bedford Harbor was placed on the National Priorities List for clean-up under Superfund legislation in 1982.

Molluscs, fish, and crustaceans accumulate PCBs. In 1979, the Massachusetts Department of Public Health closed the harbor to the taking of all fish and shellfish to protect human health because PCB residues in fish and clams found there exceeded the FDA (Food and Drug Administration) **action level** of 5 mg / kg (Fig. 14). Because particles of PCB-contaminated sediment inside the hurricane barrier can be transported outside the barrier and into Buzzards Bay by tides and currents, an area south of the barrier was closed to the taking of lobsters and bottom feeding finfish. An area further south, was closed to the taking of lobsters.

In 1994 and 1995, the Army Corps of Engineers dredged about five acres of sediment in the upper harbor that contained the highest concentrations of PCBs, the area called the hot spot. The dredge spoil is currently stored in a contained disposal facility (CDF) until a decision is made on how to dispose of this highly contaminated sediment. The second phase of the project, during which an additional 170 acres of less contaminated sediment will be dredged, is scheduled to begin after a disposal method is selected. Scientists are conducting a 30-year post-dredging **monitoring** study in New Bedford Harbor to assess the effects of remediation.

As in the earlier periods, the numerous metal-working industries in New Bedford were a source of pollutants during the post-textile period. Other industries that were potential sources of pollutants included oil refining and storage, electricity generation, and the manufacture of paint, glass, rubber products, and plastics. They may have released metals, acids, petroleum hydrocarbons, phenols, cyanide, solvents, and synthetic chemicals into the environment.

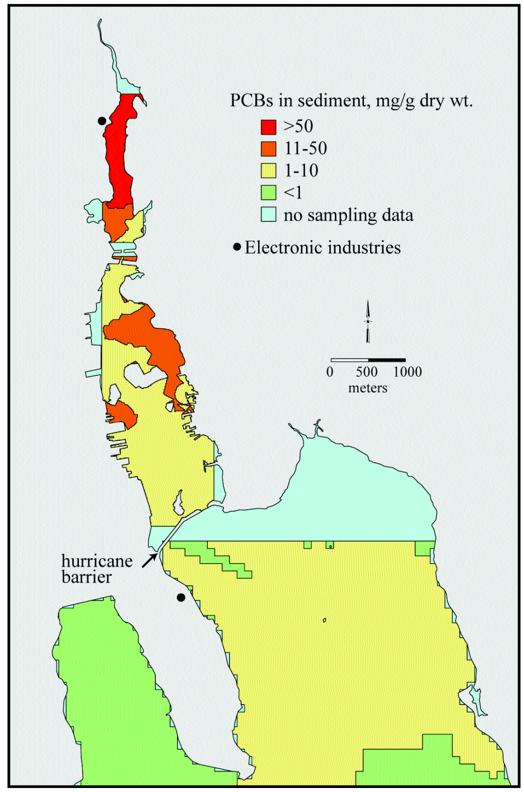


Fig. 13. Concentrations of PCBs in sediments in New Bedford Harbor were exceedingly high in the upper harbor adjacent to the electronics part manufacturing company.

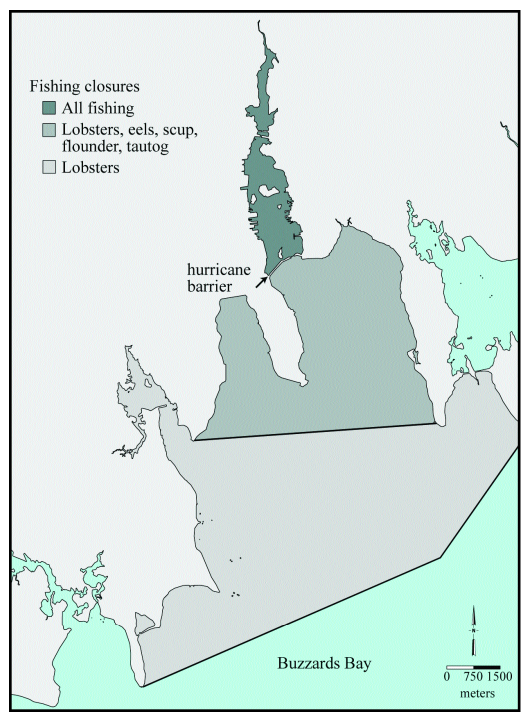


Fig. 14. In 1979, the harbor and areas south of the hurricane barrier were closed to fishing and/or shellfishing because PCB residues in fish and shellfish exceeded the FDA action level of 5 mg/kg.

Contaminants in the Environment

There are two issues to consider about environmental contaminants: fate - what happens to the contaminant when released to the environment, and effect - what kind of damage is done. Some contaminants are short-lived in the environment and affect only the immediate areas for a short time, while others persist for decades. Chemical contaminants may remain at the area of release or may be transported to other locations. For example, chemicals dumped on the ground may absorb to soil particles and persist for decades in the soil. Some chemicals leach into the groundwater or adjacent streams, rivers, and lakes and are transported away from the site of disposal. Soil type also affects fate of chemicals. Some soils, for example sand, are more permeable - water can pass through readily and c rry contaminants into the groundwater. Other soils, for example clay, are less permeable - liquids filter through slowly and surface runoff carries the contaminants into nearby water bodies. Some chemicals will adsorb to the organic fraction of soils. Some chemicals dumped into water bodies are adsorbed by the bottom sediments and persist for decades. Chemical contaminants emitted into air may be carried miles by prevailing winds.

The effect of any chemical contaminant depends on its toxicity and the quantity released. At high concentrations, contaminants dumped into water bodies can cause acute toxicity (death) to aquatic organisms, whereas at lower concentrations they may cause chronic effects, such as decreased growth rate, reduced offspring, nervous system disorders, or may be accumulated in the tissues of the exposed organisms. Edible species may accumulate high enough concentrations of certain chemicals that they pose a human health threat; for example, fish and shellfish from New Bedford Harbor have accumulated PCBs and are unsafe to eat. Since some species of plants and animals are more sensitive than others, pollutants may cause changes in the species composition by affecting the more sensitive species, while the more tolerant ones survive.

The groups of contaminants mentioned in the text all pose some sort of problem when released into the environment. The fate and effect of contaminants released in the Acushnet River watershed are described in general terms in the next column; the particular effect of a contaminant depends on the individual chemical or mix of chemicals, the amount released, and the physical characteristics of the disposal site.

Metals are toxic, adsorb to sediments, can be accumulated by organisms, persist in the environment, and have been widely used in many industrial processes. Sediments in New Bedford Harbor contain high concentrations of metals, particularly copper, chromium, zinc, and lead.

Cyanides are highly toxic and persistent in the environment. They were used by a number of industries in the 1800s, but are now regulated.

Petroleum hydrocarbons are comprised of hundreds of organic compounds derived from petroleum. Toxicity and persistence depend on the particular fraction of petroleum. Some petroleum fractions are volatile (evaporate easily). Although these compounds are toxic, they usually are not harmful to organisms because they do not persist in the environment. Whereas other fractions are not very reactive, persist in the environment, and are toxic. Oils and grease are general terms for some petroleum hydrocarbons.

Phenols, a particular group of organic chemicals, vary in toxicity and tend to be less persistent in the environment.

Solvents, a term that indicates a group of chemicals distinguished by their industrial use, not chemical structure, are usually organic chemicals. Solvents vary in toxicity and persistence in the environment.

Acids can cause acute effects in the immediate vicinity of disposal, however acids are quickly buffered and do not persist in the environment.

Lye and caustic cleaning agents are highly toxic. They can cause acute effects in the immediate disposal area, but are very reactive and do not persist in the environment.

Biological waste can cause acute, short-term effects when disposed in water. Biological waste contains organic matter, which consumes dissolved oxygen (DO) when it decomposes. The amount of DO in waters can be lowered so much that resident plants and animals can not survive. ■

Summary

The summary table presents a review of historic and current activities within the Acushnet River watershed and the associated ecological effects. During the agricultural period (1650-1765), some land was cleared by early subsistence farmers. Our estimates of the amount land cleared indicate that the ecological effects were minimal. During the whaling period (1750-1900), the building of wharfs and the New Bedford-Fairhaven Bridge altered currents in the harbor and caused sedimentation patterns to change. Early industries discharged contaminants into the harbor. Although the volume of discharge was much less than in later periods, it was present and may have impacted the harbor. The initial sewer system, built in the nineteenth century, established the practice of discharging wastes directly into the harbor.

Summary of Ecological Effects of Development on New Bedford Harbor

Agricultural: 1650-1780	
Cleared land, farmed	Minimal impact
Whaling: 1750-1900	
Built wharfs	Altered currents and sedimentation
New Bedford – Fairhaven Bridge	Altered currents and sedimentation
Industries	Contaminated sediment in harbor
Textile: 1880-1940	
Built mills on wetlands	Loss of habitat and filtering capability
Dramatic population increase Increased sewage input	Increased organic matter, low oxygen concentration, low species diversity, closed shellfish beds, typhoid fever
Industries	Contaminated sediment in harbor
Post-Textile: 1940-present	
Electronics industries	PCB contamination in harbor
Other industries	Contaminated sediment in harbor
Hurricane barrier	Altered circulation patterns

During the textile period (1880-1940), wetlands were filled and mills were built on the filled land. The loss of these wetlands meant decreased habitat available for resident and migratory species and decreased nursery areas for aquatic species. The function of these wetlands, filtering excess nutrients, pollutants, and microorganisms in runoff from the land, was also lost. The dramatic increase in population led to an increase in sewage inputs to the harbor. Residents contracted typhoid fever from eating shellfish from the harbor that were contaminated by bacteria found in sewage. Shellfish beds have remained closed since 1904. Industries continued to discharge wastes into the harbor.

In the post-textile period (1940 - present), the electronics industries contaminated the harbor with PCBs. Other industries continued to release metals and organic compounds into the harbor. The hurricane barrier, built to protect the commercial fishing fleet and coastal businesses, affected sedimentation patterns, increased water residence times, and altered water circulation patterns, so that wastes may reenter the harbor.

Which of these environmental effects could potentially be remediated? The alterations made by the building of wharfs, the New Bedford-Fairhaven bridge, the hurricane barrier, and the filling of wetlands are seemingly irreversible. The PCB contamination in the harbor is being remediated by the dredging projects currently being conducted by the Army Corps of Engineers.

Some PCB-contaminated sediment is also highly contaminated by metals, therefore, remediation of some metal-contaminated sediment will coincidentally occur with the dredging. However, at the present time, there are no further plans to deal with sediments contaminated by chemicals other than PCBs. An industrial pretreatment program, where industries remove contaminants from their wastes prior to putting them into the sewer system, was instituted in 1985, so fewer contaminants are discharged. There has been some remediation of the sewage problem. In 1974, a wastewater treatment plant, with primary treatment of waste, was built. Secondary treatment of waste was instituted in 1996, when a new wastewater treatment facility was finished and brought into operation. This has improved the quality of the effluent discharged from the plant, located at the end of Clarks Point. However, there are still discharges of untreated wastes into the harbor from the combined sewer overflows (CSOs) during periods of heavy rain. Also, the outfall from the Fairhaven Wastewater Treatment Facility (secondary treatment), built in 1969, discharges effluent into the lower harbor.

View toward Fairhaven from Popes Island Marina, New Bedford. Whale tail sculpture is by Roger Lewis, a New Bedford artist. Photograph by Carol Pesch.

It is clear from examining the history of the Acushnet River watershed that human activities, economic development, and urbanization have affected ecological conditions in the harbor. Throughout the history of the watershed, choices were driven by the desire of local citizens to succeed economically. New Bedford became very prosperous by investing primarily in one industry at a time, first with whaling and whaling-related business, then textiles. But this one-industry-at-a-time approach left the area very vulnerable to changes in regional and national conditions and led to economic decline in the post-textile period.

During the whaling and textile periods, just a handful of families controlled the economic decisions. Immigrants, brought in to work in the mills, diversified the population, but the economic power was still exercised by a small percentage of the population, those in control of the mills and banks. When competition from the southern mills and effects of the Great Depression led to the decline of the textile industry, New Bedford attempted to attract a variety of businesses. However, the city did not regain the economic prosperity that existed at the height of the whaling and textile periods.

With economic decline and the resulting loss to the city's tax base, New Bedford could not make improvements in its sewer system. Discharges of sewage and industrial wastes continued to enter the harbor. In the 1970s, the discovery of PCBs in the harbor sediments brought attention to the highly contaminated state of the harbor. The problems could no longer be ignored.

There has been a change in how decisions, especially those about environmental problems, are made. Now, there is much wider input from the citizens of the watershed. This is consistent with the national trend to involve communities and citizens in solving environmental problems. Local problems cannot be solved from Washington. It is appropriate for local residents, who care about their own environment, to get involved.

History has taught us that a few individuals can make a difference. There are a number of citizen groups in the New Bedford area. Some groups are contributing to the protection of the environment, other groups are working to preserve historic buildings or maintain a healthy economic environment in downtown New Bedford.

This historical profile presents a realistic picture of environmental conditions in the New Bedford Harbor. Although the harbor can not be restored to pristine conditions, it can be improved and protected, especially through community-based efforts. ■

Community Organizations in New Bedford

Environmental Groups

Coalition for Buzzards Bay
17 Hamilton Street
New Bedford, MA 02740
508-999-6363
This membership-supported non-profit organization is concerned about the restoration, protection, and sustainable use of Buzzards Bay and its watershed. The Coalition works to improve the health of Buzzards Bay ecosystem through education, conservation, research, and advocacy.

Concerned Parents of Fairhaven
This citizens group was active in seeking safe disposal options during the first phase of the New Bedford Harbor dredging project.

Downwind Coalition of Marion
The goal of this community organization was to seek alternatives technologies for disposing the PCB-contaminated wastes dredged from New Bedford Harbor during the first phase of the dredging project.

Hands Across the River Coalition
222 Union Street,
Room 202,
New Bedford, MA 02740
508-979-5910
Hands Across the River Coalition is a citizens group concerned about the safe clean-up of the Acushnet River and New Bedford Harbor.

Sea Change, Inc.
60 Spring Street
Marion, Ma 02738
508-748-9655
Sea Change is a not-for-profit organization that assists communities to make informed decisions by providing citizens with independent scientific and technical information in non-technical language. They were founded in response to issues concerning the PCB contamination in New Bedford Harbor, but now also work on environmental issues in other locations.

Other Groups

Downtown New Bedford, Inc.
106 William Street
New Bedford, MA 02740
508-990-2777
This nonprofit community organization works to maintain a healthy economic and social environment in downtown New Bedford.

WHALE
(Waterfront Historic Area LeaguE)
62 North Water Street
New Bedford, MA 02740
508-997-1776
WHALE is a nonprofit community organization dedicated to preserving historic buildings in New Bedford and surrounding communities.

How to do a Historical Reconstruction of Ecological Impacts

Become familiar with local history - Use the resources at local libraries and historical societies to learn about local history. State historical commissions may also have reports that include the history of individual towns. Concentrate on sources that give the big picture. You can go back and get the details later.

Look at old maps of the area - Locate facilities (local library, local and state historical societies, university libraries, state library, and state archives) that have historic maps of the area of interest. Compare coastlines and wetlands on older maps to current ones.

Visit the area - Drive around the area and get to know the residential, commercial, and industrial areas. Look for old buildings and learn the location of the "old section" of town.

Research former industries - Reports of local boards of trade and town or city directories list industries and businesses. Sanborn Maps (fire insurance maps) give locations of former industries and may indicate the industrial processes or types of materials stored in the buildings.

Research city and state health reports - Check state libraries for state or city Department of Health reports to learn of "nuisances" (odor problems from sewage or other sources) or outbreaks of diseases that may be related to environmental conditions; for example, from 1900 to 1903 there was an outbreak of typhoid in New Bedford that was caused by consumption of contaminated shellfish.

Research city, state, and government engineering reports - Check state libraries for engineering reports and city halls for Board of Public Works and Department of Engineering reports to learn about possible environmental effects. For example, an Army Corps of Engineers report, dated 1853, documented the change in hydrography in New Bedford Harbor after the New Bedford-Fairhaven Bridge was built.

Check newspaper libraries - Some newspapers maintain archives of articles that have appeared in their papers. These are often arranged by subject; for example, sewerage or sewer system, hurricanes, or particular industries in the area. Newspaper articles can also be found on microfilm at local libraries. These articles are a good way to see what issues were important to residents.

Make a time line - Atime line with significant local, regional, and national events will help put local events in perspective and give an understanding of why development occurred as it did. It will also help to identify time periods associated with development and environmental effects.

Each area has its own unique history - Use that as a guide to identify the environmental effects associated with development of the area.

Glossary

action level - chemical concentration in food above which consumption of that food would pose a health risk

baleen - the boney plate in the mouths of certain kinds of whales that was used to make corset stays, hoops for women's skirts, frames for hats, fans, umbrella ribs, and fishing rods

benthic - bottom-dwelling, at the surface of or in the sediment

carcinogenic - a chemical or substance that produces or incites cancer

combined sewer overflows (CSO) - a system of waste removal where storm run-off from streets empties into the same pipes as domestic and industrial wastes.

diversity - number and variety of different organisms in the environment in which they naturally occur

dredge spoil - sediment dredged (removed) from the bottom of a harbor, river, or lake

estuarine - having to do with or found in an estuary

estuary - regions of interaction between rivers and near-shore ocean waters, where river flow and tidal action mix fresh and salt water

gyre - a circular movement

habitat - place where a population or community lives, and its surroundings, both living and non-living

hydrographic - having to do with the description and study of bodies of water (seas, lakes, rivers): as in surveying and charting; measuring flow, currents, and tides; and sounding (measuring depth)

monitoring study - a study to assess the status of physical and biological conditions of a particular area at specified intervals (e.g. monthly, seasonally, yearly) over a given time period (usually years)

mutagenic - a substance that increases the frequency of mutation, the alteration in hereditary material

nuisance - a term used in the late nineteenth century to refer to any environmental problem, e.g. odor nuisance, garbage nuisance

opportunistic - to take advantage of. An opportunistic species can take advantage of adverse conditions and thrive in locations where more sensitive species will not survive.

organic compounds - generally all compounds that contain the element carbon, with a few exceptions, e.g. $CaCO_3$

permeable - having openings that liquids (or gasses) can pass through

polychlorinated biphenyls (PCBs) - a group of closely related and manufactured chemicals made up of carbon, hydrogen and chlorine, specifically, two 6-carbon rings (biphenyl - $C_6H_5^+$) with two or more chlorine atoms substituted for hydrogen

polycyclic aromatic hydrocarbons (PAHs) - a class of chemical compounds composed of fused six-carbon rings. PAHs are commonly found in petroleum oils and are emitted from various combustion processes (automobile exhaust, burning of wood and coal).

remediation - action to remedy or correct damage to the environment

species composition - the species found in a particular area

Superfund - a special trust fund, established by a federal law passed in 1980, to help finance the investigation of waste sites

teratogenic - a substance that causes developmental malformations

topography - the configuration of a surface showing relief (elevations) and position of natural and man-made features

toxic - a substance that is poisonous, carcinogenic, or otherwise harmful to plants and animals

watershed - the entire area of land whose runoff of water, sediments, and dissolved materials (nutrients, contaminants) drain into a lake, river, estuary, or ocean

water quality criterion - the maximum concentration of a chemical in ambient waters that would be safe for aquatic species. The criterion are determined from the results of toxicity tests using a variety of aquatic species, and consider both short-term and long-term exposures.

water residence time - amount of time water remains inside a specified area, e.g. harbor, bay, etc.

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